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PATENT APPLICATION AF IFW $

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IN THE
UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s): Theodore I. Kamins et al.

Confirmation No.: 4949

Application No.: 10/029,583

Examiner: R.G.McDonald

Filing Date: Dec. 20, 2001

Group Art Unit: 1753

Title: Method of Forming One or More Nanopores for Aligning Molecules for Molecular Electronics

Mail Stop Appeal Brief-Patents
Commissioner For Patents
PO Box 1450
Alexandria, VA 22313-1450

TRANSMITTAL OF APPEAL BRIEF

Sir:

Transmitted herewith in **triplicate** is the Appeal Brief in this application with respect to the Notice of Appeal filed on **Aug. 26, 2004**.

The fee for filing this Appeal Brief is (37 CFR 1.17(c)) $330.00.

(complete (a) or (b) as applicable)

The proceedings herein are for a patent application and the provisions of 37 CFR 1.136(a) apply.

( ) (a) Applicant petitions for an extension of time under 37 CFR 1.136 (fees: 37 CFR 1.17(a)-(d) for the total number of months checked below:

( )	one month	$110.00
( )	two months	$420.00
( )	three months	$950.00
( )	four months	$1480.00

( ) The extension fee has already been filled in this application.

(X) (b) Applicant believes that no extension of time is required. However, this conditional petition is being made to provide for the possibility that applicant has inadvertently overlooked the need for a petition and fee for extension of time.

Please charge to Deposit Account **08-2025** the sum of **$330.00**. At any time during the pendency of this application, please charge any fees required or credit any over payment to Deposit Account 08-2025 pursuant to 37 CFR 1.25. Additionally please charge any fees to Deposit Account 08-2025 under 37 CFR 1.16 through 1.21 inclusive, and any other sections in Title 37 of the Code of Federal Regulations that may regulate fees. A duplicate copy of this sheet is enclosed.

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Respectfully submitted,

Theodore I. Kamins et al.

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PD10018774-1 Appeal Brief

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PATENT
PD-10018774-1

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re Application of: Confirmation No.: 4949

THEODORE I. KAMINS ET AL.

Serial No.: 10/029,583 Group Art Unit: 1753

Filed: December 20, 2001 Examiner: R. G. McDonald

For: METHOD OF FORMING ONE OR MORE NANOPORES FOR ALIGNING MOLECULES FOR MOLECULAR ELECTRONICS

Mail Stop Appeal Brief - Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

APPEAL BRIEF UNDER 37 C.F.R. 1.192

Sir:

Appellants submit this Appeal Brief in connection with the above-referenced patent application which is on appeal to the Board of Patent Appeals and Interferences.

TABLE OF CONTENTS

(1) REAL PARTY IN INTEREST

The real party in interest is Hewlett-Packard Development Company, L.P., Houston, Texas, by blanket assignment from Hewlett-Packard Company, Palo Alto, California, which in turn received rights from the Appellants by assignment from the Appellants to Hewlett-Packard Company.

(2) RELATED APPEALS AND INTERFERENCES

There are no pending appeals or interferences related to the present application.

(3) STATUS OF THE CLAIMS

Claims 1-5, 7-48:	Pending and on Appeal.
Claim 6:	Canceled.

(4) STATUS OF ANY AMENDMENT FILED AFTER FINAL REJECTION

No Amendment was filed after the final rejection.

(5) SUMMARY OF THE INVENTION

A technique is provided for forming a molecule 18 or an array of molecules 18 having a defined orientation relative to the substrate 10 or for forming a mold 16 for deposition of a material therein. The array of molecules 18 is formed by dispersing them in an array of small, aligned holes 16 (nanopores), or mold, in a substrate 10. Typically, the material 14 in which the nanopores 16 are formed is insulating. The underlying substrate 10 may be either conducting or insulating. For electronic device applications, the substrate 10 is, in general, electrically conducting and may be exposed at the bottom of the pores 16 so that one end of the molecule 18 in the nanopore 16 makes electrical contact to the substrate 10. A substrate 10 such as a single-crystal silicon wafer is especially convenient because many of the process steps to form the molecular array can use techniques well developed for semiconductor device and integrated-circuit fabrication. (Abstract, page 17.)

As recited in independent Claim 1, a method for forming at least one nanopore 16 for aligning at least one molecule 18 for molecular electronic devices or for forming a mold 16 for deposition of a material is provided (Specification, page 2, lines 26-27). The method comprises:

(a) providing a substrate 12 having a first major surface 10a and a second major surface 10b, substantially parallel to the first major surface 10a (Specification, page 2, lines 28-29);

(b) forming an etch mask on the first major surface 10a, the etch mask comprising at least one nanoparticle 12 (Specification, page 2, lines 30-31);

(c) directionally etching the substrate 10 from the first major surface 10a toward the second major surface 10b, using the etch mask to protect underlying portions of the substrate 10 against the etching, thereby forming at least one pillar 110 underneath the etch mask, wherein the directional etching is carried out using reactive ion etching (Specification, page 3, lines 1-4 and page 5, lines 4-6;

(d) forming a layer of insulating material 14 on the etched substrate 10, including around the at least one pillar 110 and at least partially covering the at least one pillar 110 (Specification, page 3, lines 5-7); and

(e) removing the at least one pillar 110 to leave at least one nanopore 16 in the insulating layer 14. (Specification, page 3, lines 8-9.)

As recited in independent Claim 24, a method for forming at least one molecule 18 in a pre-selected orientation relative to a substrate 10 is provided. The method comprises:

(a) forming at least one nanopore 16 by (Specification, page 2, line 28 to page 3, line 9):

(1) providing the substrate 10 having a first major surface 10a and a second major surface 10b, substantially parallel to the first major surface 10a,

(2) forming an etch mask on the first major surface 10a, the etch mask comprising at least one nanoparticle 12,

(3) directionally etching the substrate 10 from the first major surface 10a toward the second major surface 10b, using the etch mask to protect underlying portions of the substrate 10 against the etching, thereby forming at least one pillar 110 underneath the etch mask,

(4) forming a layer of insulating material 14 on the etched substrate 10, including around the at least one pillar 110 and at least partially covering the at least one pillar 110, and

(5) removing the at least one pillar 110 to leave at least one nanopore 16 in the insulating layer 14; and

(b) dispersing the at least one molecule 18 in the at least one nanopore 16.

During the directional etching, the substrate 10 may be maintained normal to the etching source to thereby provide nanopores 16 that are substantially perpendicular to the substrate 10. Alternatively, the substrate 10 and the etching source may be maintained at a pre-selected angle relative to each other to provide nanopores 16 that are in a defined orientation relative to the substrate 10. (Specification, page 3, lines 12-16.)

The method of the present invention aligns the molecules 18 in a fixed direction, using a technique that is less sensitive to the particular molecule 18 being used. (Specification, page 3, lines 17-18.)

(6) THE ISSUES

A. Claims 1-2, 5, 7, 8, 10-13, 23, and 47 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kikuchi et al. (U.S. Patent 6,379,572) in view of Deckman et al. (U.S. Patent 4,407,695). Thus, the issue is whether the teachings of Kikuchi et al. combined with the teachings of Deckman et al. preclude patentability of Claims 1-2, 5, 7, 8, 10-13, 23, and 47 by rendering obvious the invention recited therein.

B. Claims 3, 21, and 22 are rejected under 35 USC 103(a) as being unpatentable over Kikuchi et al., *supra*, in view of Deckman et al., *supra*, as applied to Claims 1-2, 5, 7, 8, 10-13, and 23 above, and further in view of Hatakeyama et al. (U.S. Patent 6,010,831). Thus, the issue is whether the teachings of Kikuchi et al. combined with the teachings of Deckman et al. and Hatakeyama et al. preclude patentability of Claims 3, 21, and 22 by rendering obvious the invention recited therein.

C. Claims 9, 14-20, 24-26, 28-46, and 48 are rejected under 35 USC 103(a) as being unpatentable over Kikuchi et al., *supra*, in view of Deckman et al., *supra*, and further in view of Hatakeyama et al., *supra*, and further in view of Jun et al. (U.S. Patent 5,393,373). Thus, the issue is whether the teachings of Kikuchi et al. combined with the teachings of Deckman et al., Hatakeyama et al., and Jun et al. preclude patentability of Claims 9, 14-20, 24-26, 28-46, and 48 by rendering obvious the invention recited therein.

D. Claims 4 and 27 are rejected under 35 USC 103(a) as being unpatentable over Kikuchi et al., *supra*, in view of Deckman et al., *supra*, and further in view of Hatakeyama et al., *supra*, and further in view of Jun et al., *supra*, and further in view of Brandes et al. (U.S. Patent 5,900,301). Thus, the issue is whether the teachings of Kikuchi et al. combined with the teach-

ings of Deckman et al., Hatakeyama et al., Jun et al., and Brandes et al. preclude patentability of Claims 4 and 27 by rendering obvious the invention recited therein.

(7) GROUPING OF THE CLAIMS

Claims 1-5 and 7-48 are to be considered as a group.

(8) ARGUMENTS

A. The Patentability of Claims 1-2, 5, 7, 8, 10-13, 23, and 47 over Kikuchi et al. (U.S. Patent 6,379,572) in view of Deckman et al. (Non-Obviousness).

Kikuchi et al. disclose a method for manufacturing a flat panel display in which a baseplate has a conductive row electrode deposited on it followed by an insulator. A conductive gate electrode is deposited over the insulator and a soft mask material is deposited over the conductive gate electrode. Microspheres are deposited on the soft mask material and an isotropic etch uses the microspheres as a mask to etch the soft mask material to form soft mask portions under the microspheres. The microspheres are removed and a hard mask material is deposited over the soft mask portions. The hard mask material is processed and chemical mechanical polished (CMP) down to the soft mask portions which are removed by etching to leave a hard mask which is used in an anisotropic etch process to form gate holes in the gate electrode. The gate holes are used to form emitter cavities into which emitters are deposited.

Deckman et al. disclose a natural lithographic fabrication of microstructures over large areas. Large area random and mosaic arrays of identical submicron microcolumnar structures can be produced on surfaces by directionally ion etching a monolayer film of spherical colloidal particles.

Appellants' Claim 1 recites a method for forming at least one nanopore for aligning at least one molecule for molecular electronic devices or for forming a mold for deposition of a material. The method comprises:

(a) providing a substrate having a first major surface and a second major surface, substantially parallel to the first major surface;

(b) forming an etch mask on the first major surface, the etch mask comprising at least one nanoparticle;

(c) directionally etching the substrate from the first major surface toward the second major surface, using the etch mask to protect underlying portions of the substrate against the

etching, thereby forming at least one pillar underneath the etch mask, wherein the directional etching is carried out by reactive ion etching;

(d) forming a layer of insulating material on the etched substrate, including around the pillar(s) and at least partially covering the pillar(s); and

(e) removing the pillar(s) to leave at least one nanopore in the insulating layer.

Claims 2, 5, 7, 8, 10-13, 23, and 47 depend, directly or indirectly, from Claim 1.

The Examiner essentially argues that the process of Kikuchi et al., which is directed to making microscale holes, could be modified by the process of Deckman et al., which is directed to making microcolumnar posts, or pillars. The Examiner admits that Kikuchi et al. do not discuss utilizing nanoparticles and do not discuss reactive ion etching. The Examiner cites Deckman et al. for its purported showing of directional ion etching to form microcolumnar structures that are as small as 50 Å, citing Col. 6, line 29.

The Examiner appears to be suggesting that a process for making microscale ***pores*** can be combined with a process for making solid nanoscale ***pillars***, and that this combination somehow discloses Appellants' method for forming nanopores for aligning at least one molecule for molecular devices or for forming a mold for deposition of a material therein.

In response thereto, the Examiner argues that the motivation for combining Kikuchi et al. with Deckman et al. is that it allows for producing pillars to be used in subsequent processing steps.

The Examiner appears, however, to have lost sight of Appellants' method. The Examiner argues on page 6 of the Office Action that it would have been obvious to one of ordinary skill in the art to have modified Kikuchi et al. by utilizing nanoparticles of a particular size that will produce holes of a particular size and reactive ion etching as taught by Deckman et al. "because it allows for producing a large area lithographic mask on the surface of the substrate".

First, the holes of Kikuchi et al. are only a controlled ("particular") size if the nanoparticles form a perfectly uniformly spaced array. In direct contrast, Appellants' claimed method does not require a uniform packing of the nanoparticles to obtain a uniform pore size.

In response thereto, the Examiner argues that Appellants' claims are silent on the packing style required and would read on any packing style.

In point of fact, the process of Kikuchi et al. compared to Appellants' process is like comparing a positive photographic print and a negative photographic print – there simply is no comparison. Appellants are not interested in identifying a packing style, and while this is necessary for the process of Kikuchi et al., it is not necessary for Appellants' process.

Second, Appellants are not claiming a process for producing a large area lithographic mask. Kikuchi et al. disclose the fabrication of a flat panel display with spaced apart gate emitter openings. Deckman et al. disclose the fabrication of submicron microcolumnar structures. Neither reference discloses or even remotely suggests a method for forming at least one nanopore for aligning at least one molecule therein. Consequently, the combination utterly fails to suggest such a method.

In response thereto, the Examiner argues that Kikuchi et al. teach forming a pore on a substrate which, for example, from Appellants' Claim 1(e) is the desired result. The Examiner further argues that Deckman et al. suggest that the size of a pillar can be achieved by utilizing particles of nanosize. The Examiner concludes that from Kikuchi et al., one can follow through with the subsequent steps of removing the pillar to produce the nanopore.

The test for obviousness is not whether the Examiner can find bits and pieces of Appellants' method disclosed in the references, using Appellants' own disclosure for guidance. The test, rather, is whether there is some teaching, suggestion, or incentive supporting the combination. There is no disclosure or suggestion in either reference of the desirability of combining the references. Indeed, the Examiner is attempting to combine the teachings of a reference directed to forming gate emitter ***openings***, or ***voids***, with a reference directed to forming microcolumnar structures (***pillars***). Even if the references are combined, the combination fails to disclose or suggest Appellants' method for forming at least one nanopore for aligning at least one molecule therein. Specifically, neither reference is directed to forming nanopores for aligning molecules therein or for forming a mold for deposition of a material therein.

In response thereto, the Examiner argues that it is obvious to combine the references in order to produce the nanoscale openings.

Appellants have fully responded to this argument above.

Third, contrary to the Examiner's assertion that Deckman et al. teaches reactive ion etching (RIE); Deckman et al. in fact do ***not*** disclose reactive ion etching. Rather, Deckman et al. disclose "ion etching" (Abstract), reactive ion ***beam milling*** (e.g., Col. 7, lines 18-19 and Col. 8, line 14), "beam of ions" (Col. 1, line 53 and Col. 4, line 49), "isotropic plasma etching process" (Col. 5, line 2), "Argon Ion ***beam milling***" (Col. 6, lines 65-66), "directional ion etching" (this is ion beam, not RIE) (Col. 7, line 6), "reactive ion ***milling***" (Col. 7, line 66), "reactive ***plasma***" (Claims 3, 8). (Emphasis added.) One skilled in the art would know that these are not merely alternative expressions for reactive ion etching, but rather are similar terms directed to totally different processes than RIE.

B. The Patentability of Claims 3, 21, and 22 over Kikuchi et al. (U.S. Patent 6,379,572) in view of Deckman et al. and Hatakeyama et al. (Non-Obviousness).

Kikuchi et al. and Deckman et al. are discussed above.

Hatakeyama et al. disclose an ultra-fine microfabrication method using an energy beam based on the use of shielding [masking] provided by nanometer or micrometer sized microparticles to produce a variety of three-dimensional fine structures which, purportedly, have not been possible by the traditional photolithographic technique which is basically designed to produce two-dimensional structures. When the basis technique of radiation of an energy beam and shielding is combined with a shield positioning technique using a magnetic, electrical field, or laser beam, with or without the additional chemical effects provided by reactive gas particle beams or solutions, fine structures of very high aspect ratios are purportedly produced with precision. Applications of devices having the fine structures produced by this method are said to include wavelength shifting in optical communications, quantum effect devices, and intensive laser devices.

Appellants' Claims 3, 21, and 22, which depend directly or indirectly from Claim 1, specify the size of the nanoparticle (Claim 3) and the dimensions of the nanopore (Claims 21 and 22).

The arguments made above regarding the first two references obtain here as well. The Examiner is attempting to add to the combination the Hatakeyama et al. reference without regard to its teachings. Hatakeyama et al. disclose a process for making solid nanoscale cones. Topologically, the cones of Hatakeyama et al. and the pillars of Deckman et al. are the same. Thus, the Examiner appears to be suggesting that a process for making microscale pores can be combined with processes for making solid cones and pillars, and that this combination somehow discloses Appellants' method for forming nanopores for aligning at least one molecule for molecular devices or for forming a mold for deposition of a material therein.

Again, the test for obviousness is not whether the Examiner can find bits and pieces of Appellants' method disclosed in the references, using Appellants' own disclosure for guidance. The test, rather, is whether there is some teaching, suggestion, or incentive supporting the combination. There is no disclosure or suggestion in either reference of the desirability of combining the references. Indeed, the Examiner is attempting to combine the teachings of a reference directed to forming gate emitter ***openings, or voids,*** with references directed to forming **solid** microcolumnar structures (***pillars***) and solid nanoscale ***cones***. Even if the references are combined,

the combination fails to disclose or suggest Appellants' method for forming at least one nanopore for aligning at least one molecule therein. Specifically, neither reference is directed to forming nanopores for aligning molecules therein or for forming a mold for deposition of a material therein.

The Examiner appears to be suggesting that nanoparticles of a particular size are identical to nanopores of a particular size. This is not accurate. The use of a masking particle of a particular size does not necessarily result in a pore of the identical size, and the use of a masking nanoparticle does not necessarily result in a nanopore of the identical size. Further, a nanoparticle is matter, and a nanopore is the absence of matter. Stated another way, a nanoparticle is a physical feature having a prescribed dimension. A nanopore is a void having a prescribed dimension.

In addition to the foregoing, the Examiner is attempting to combine a reference that is silent as to the use of any beam as part of the process (Kikuchi et al.) with a first reference that teachings reactive ion beam etching (Deckman et al.) and with a second reference that teaches use of an energy beam with a reactive gas particle beam, wherein the energy beam is a fast atomic beam (FAB). This approach by the Examiner is indulging in the impermissible act of selecting bits and pieces of prior art, based on Appellants' own claims, to reject the application, without regard to the teachings of the references as a whole.

It should be noted that the Hatakeyama et al. process requires an energy beam, with its attendant extreme directionality, to produce the fineness of his features. Such a beam does not disclose or suggest reactive ion etching. And, as discussed above, reactive ion beam etching is a different, and patentably distinct, process than reactive ion etching. The former is essentially reactive milling with a reactive gas, whereas the latter is etching with a plasma.

<u>C. The Patentability of Claims 9, 14-20, 24-26, 28-46, and 48 over Kikuchi et al. (U.S. Patent 6,379,572) in view of Deckman et al., Hatakeyama et al. and Jun et al. (Non-Obviousness).</u>

Kikuchi et al., Deckman et al., and Hatakeyama et al. are discussed above.

Jun et al. discloses methods of hyperfine patterning and manufacturing semiconductor devices. The steps include coating a hemisphere particle layer having hills and valleys on a layer to be etched, the hemisphere particle layer having an etch selectivity higher than that of the first layer, filling the valleys of the hemisphere particle layer with a second layer having an etch selectivity higher than that of the hemisphere particle layer, and etching back the hills of the hemi-

sphere particle layer to expose the first layer by using the second layer as a mask, and etching the first layer. By virtue of the hemisphere particle layer having alternating hills and valleys, it is purportedly possible to accomplish a hyperfine patterning of about 0.1 μm.

Claims 9 and 14-20 depend, directly or indirectly, from Claim 1.

The Examiner argues that Jun et al. teach depositing insulation material by CVD (relevant to Appellants' Claim 9) and filling the valleys with material (relevant to Appellants' Claims 14-20).

However, the combination of Kikuchi et al. and Hatakeyama et al. has been shown above to be flawed, and hence the combination of Kikuchi et al. with Hatakeyama et al. and Jun et al. likewise falls.

With regard to independent Claim 24, that claim recites a method for forming at least one molecule in a pre-selected orientation relative to a substrate. The method comprises: (a) forming at least one nanopore (essentially employing the method of Claim 1); and (b) dispersing at least one molecule in at least one nanopore.

Claims 25, 26, 28-46, and 48 depend, directly or indirectly, from Claim 24.

Jun et al. are totally silent on the concept of filling their valleys with at least one molecule. The Examiner contends that this reference teaches depositing material in the valleys, which the Examiner equates to Appellants' nanopores. The material (dielectric layer 16 and polysilicon layer 17) is actually used to coat the upper surface of polysilicon layers 24 and 27 to produce a capacitor. A process for depositing a dielectric ***layer*** and a polysilicon ***layer*** in a valley hardly suggests disposing at least one ***molecule*** in a nanopore. Is the Examiner suggesting that a crystalline or polycrystalline material is equivalent to a molecule?

In response thereto, the Examiner argues that "at least one molecule could include more than one molecule and the layer of would include at least one molecule" [*sic*].

The Examiner's argument makes no sense in the context of Appellants' invention.

Accordingly, Claim 24, together with Claims 25-26 and 28-46, are clearly patentable over the combination of references.

The Examiner acknowledges on pages 8-9 of the Office Action that Jun et al. teach the manufacture of ***semiconductor*** devices. In direct contrast, Appellants' claims are directed to ***molecular*** devices, not semiconductor devices. Appellants' method claims recite a method for forming at least one nanopore for aligning at least one molecule for molecular electronic devices (Claim 1) and a method for forming at least one molecule in a pre-selected orientation relative to

a substrate (Claim 24). Appellants are specifically interested in a molecular device where the enabling material is the molecule. This is vastly different than a semiconductor device.

The Examiner appears to be saying that because the semiconductor device of Jun et al has two terminals, then it is citable against molecular devices, which also have two terminals. Any two terminal device must have two contacts. This does not make semiconductor devices, or capacitors, equivalent to molecular devices. Indeed, resistors, capacitors, and inductors each have two terminals, and no one would say that they are equivalent to each other, even though they use some of the same building materials.

The Examiner argues on page 9 of the Office Action that the "motivation for utilizing CVD to deposit the insulating material, depositing material in the nanopore, utilizing an electrical substrate of doped polycrystalline silicon, a tunnel barrier layer and the material being semiconductive is that it allows for the production of a semiconductor device."

Appellants can find no mention of a tunnel barrier in the references cited, and has previously requested that the Examiner specifically cite the location in the reference(s) where a tunnel barrier is mentioned. In the absence of such citation, Appellants have urged that at least Claims 19 and 42 are patentable over the references. The Examiner has not provided such citation.

Jun et al. discloses a capacitive device; tunneling would destroy such a device, since it would no longer function as a capacitor. Thus, the teachings of Jun et al. are ***contrary*** to Appellants' claims. Furthermore, while Jun et al. may imply barriers, this does not mean that these barriers are tunneling. Instead, such barriers of Jun et al. are intended to ***prevent*** tunneling. Although any barrier has some finite probability of tunneling, any tunneling of Jun et al. would occur over a time period of many years, which would not provide a useful device based on tunneling.

In response thereto, the Examiner argues that Appellants admit that Jun et al. at least imply barriers and that there would be a finite probability of tunneling and therefore, this suggests at least a tunnel barrier layer.

Again, the Examiner's argument makes no sense in the context of Appellants' invention. Concrete would presumably have a theoretical quantum mechanical probability of tunneling, but no sensible worker in this art would suggest constructing tunneling devices out of concrete.

Finally, Jun et al. disclose hyperfine patterning of about 0.1 μm, which is about 100 nm. Appellants' claimed range is 1 to 10 nm, or 10 to 100 times ***smaller***.

D. The Patentability of Claims 4 and 27 over Kikuchi et al. (U.S. Patent 6,379,572) in view of Deckman et al., Hatakeyama et al., Jun et al., and Brandes et al. (Non-Obviousness).

Kikuchi et al., Deckman et al., Hatakeyama et al., and Jun et al. are discussed above.

Brandes et al. disclose the structure and fabrication of electron-emitting devices utilizing electron-emissive particles which contain carbon.

Appellants' Claim 4 depends from Claim 1 and recites the structure of the nanoparticle(s) used in the method of Claim 1, namely, an inorganic crystalline core covered with an organic layer.

The Examiner argues that Brandes et al. teach applying carbon particles for etching and that the particles are applied though an organic solvent.

Appellants have shown above that the combination of Kikuchi et al. and Hatakeyama et al. falls with respect to amended Claim 1. Accordingly, the combination of Kikuchi et al., Hatakeyama et al., Jun et al., and Brandes et al. also falls.

The Examiner also seems to be suggesting that carbon particles suspended in an organic solvent are somehow equivalent to Appellants' inorganic crystalline core covered with an organic layer. Appellants' inorganic core and organic shell are essentially a unit, used as the nanoparticle to form the nanopore. As is evident from Appellants' paragraph 0021, the organic layer does not serve to suspend the particles in the liquid (as taught by Brandes et al.). Rather, the function of the organic layer is to keep the inorganic cores from touching and joining. In some cases, the particles do not have an organic coating. They still function the same, but the particles do not stay in suspension as long and need to be kept under specific conditions, for example, refrigerated. Thus, the organic coating is not critical; it only makes the process more robust.

The Examiner argues on page 10 of the Office Action that the "motivation for utilizing a particle that is inorganic coated with an organic is that it allows for developing pillars when anisotropic etching takes place".

Appellants fail to see the Examiner's logic. Coating the inorganic core with an organic material does not seem to have anything to do with developing pillars when anisotropic etching is used. Further, it is not obvious how a carbon particle suspended in a solvent teaches an inorganic particle surrounded by an organic (solid) material.

In response thereto, the Examiner argues that the organic material is not required to be a solid, and thus a liquid layer surrounding the carbon particle would read on the claimed subject matter.

Appellants' nanoparticle is a complete unit (inorganic crystalline core covered by an organic layer). This is to be distinguished from carbon particles in a solvent. The common definition of an organic material is that it is carbon-containing. An ***organic*** core could hardly be fairly considered to suggest a ***crystalline inorganic*** core.

Appellants' Claim 27, which is analogous to Claim 4, depends from independent Claim 24. As shown above, the combination of Kikuchi et al., Hatakeyama et al., and Jun et al. utterly fails to disclose or even remotely suggest a method for forming a molecule in a pre-selected orientation relative to a substrate, as recited in Claim 24. Accordingly, the combination of Kikuchi et al., Hatakeyama et al., Jun et al., and Brandes et al. also falls.

E. Additional Considerations.

None of the references cited by the Examiner deal with forming nanopores in which each nanopore contains a single molecule, as recited in Claims 47 and 48 that were added during prosecution. The cited references fail to even remotely suggest such a configuration. Thus, at the very least, Claims 47 and 48 must be deemed patentable over any combination of the cited references.

In response thereto, the Examiner argues that the claims require "at least one molecule" and the nanopore "contains" one molecule, which suggests one molecule, but can include more than one molecule based on the language of the claims.

It is true that the independent claims recite "at least one molecule" and "at least one nanopore". However, Claims 47 and 48 specifically recite that each nanopore contains "one said molecule". Appellants fail to see how such language allows more than one molecule in a nanopore. A nanopore is a container for a molecule. Here, Claims 47 and 48 recite only one molecule in each nanopore. Paragraph 0032 describes how the nanopores 16 are intended, at least in some applications, to be approximately the size of molecules that are to be placed in them. For example, many long-chain molecules are about 10 nm long and about 1 nm in diameter. The size (diameter) of the nanopores 16, of course, depends on the size of the pillars 110. Broadly, however, the nanopores 16 may be formed having a length within the range of about 5 to 100 nm and a diameter within the range of about 1 to 10 nm. It is expected that the aspect ratio (length:diameter) is likely to be less than about 100:1 and, for practical considerations, less than about 25:1. Appellants submit that the Examiner is going to extraordinary lengths to subvert the plain language of Claims 47 and 48.

It is clear that the Examiner is extracting bits and pieces from each of the cited references in order to cobble together a facsimile of Appellants' claims. The Examiner is reminded that

> "[t]he test for obviousness is not whether the features of one reference may be bodily incorporated into another reference. . . . Rather, we look to see whether combined teachings render the claimed subject matter obvious."

In re Wood, 202 USPQ 171, 174 (C.C.P.A. 1979).

The claim must be considered ***as a whole***. The inclusion of separate references in a rejection to represent each of the different features described in the claims of the application is a sign that the Examiner is attempting to piece together the claimed invention using the claims as a guide. That is, the Examiner is using Appellants' claims as an instruction manual to find the appropriate prior art that might render the claims obvious. In this process, the Examiner has lost sight as to the real issue: whether it would have been obvious to combine with references ***without*** having access to the instant application. As stated by the Federal Circuit,

> "although Graham v. John Deere Co. . . . requires that certain factual inquiries, among them the differences between the prior art and the claimed invention, be conducted to support a determination of the issue of obviousness, the actual determination of the issue requires an evaluation in the light of the findings in those inquiries of the obviousness of the claimed invention as whole, not merely the differences between the claimed invention and the prior art."

Lear Siegler, Inc. v. Aeroquip Corp., 221 USPQ 1025, 1033 (Fed. Cir. 1984).

Thus, it is not correct for the Examiner merely to focus on the differences between the prior art and the claimed invention, and then to state that the differences themselves or individually are obvious. The claimed invention ***as a whole*** is to be considered. Further, it is impermissible for the Examiner to use the application itself as the basis or reason for formulating the obviousness rejection. As the Federal Circuit has stated:

> "It is impermissible to use the claimed invention as an instruction manual or 'template' to piece together the teachings of the prior art so that the claimed invention is rendered obvious. This court has previously stated that '[o]ne cannot use hindsight reconstruction to pick and choose among isolated disclosures in the prior art to deprecate the claimed invention.'"

In re Fritch, 23 USPQ 2d 1780, 1783–84 (Fed. Cir. 1992)

Not only the claimed invention as a whole must be considered, but also the prior art as a whole must be considered. See, for example, *Lindemann Maschinenfabrik GmbH v. American Hoist & Derrick Co.*, 221 USPQ 481, 488 (Fed. Cir. 1984), in which the Court stated:

> "The '315 patent specifically stated that it disclosed and claimed a combination of features previously used in two separate devices. That fact alone is not fatal to patentability. The claimed invention must be considered as a whole, and the question is whether there is something in the prior art as a whole to suggest the desirability, and thus the obviousness, of making the combination."

Note also a decision by the Federal Circuit in *Akzo N.V. v. United States International Trade Commission*, 1 USPQ 2d 1241, 1246 (Fed. Cir. 1986), cert. denied, 482 U.S. 909 (1987), in which the Court stated:

> "[P]rior art references before the tribunal must be read as a whole and consideration must be given where the references diverge and teach away from the claimed invention. . . . Moreover, appellants cannot pick and choose among individual parts of assorted prior art references 'as a mosaic to recreate a facsimile of the claimed invention.'"

The foregoing case law is cited as a reminder that the references ***as a whole*** must also be considered, even as the claimed invention ***as a whole*** must be considered. Appellants contend that the Examiner has ignored the teachings of the references as a whole in finding obviousness in their claimed invention, as discussed in response to each of the rejections above.

(9) CONCLUSION

For the reasons set forth in this Brief, the rejection of Claims 1-5 and 7-48 as being obvious over Kikuchi et al. in view of Deckman et al. or in view of Deckman et al. and Hatakeyama et al. or in view of Deckman et al., Hatakeyama et al., and Jun et al., or in view of Deckman et al., Hatakeyama et al., Jen, and Brandes et al. should be reversed and the application passed to issue.

Respectfully submitted,

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APPENDIX

CLAIMS ON APPEAL

1. A method for forming at least one nanopore for aligning at least one molecule for molecular electronic devices or for forming a mold for deposition of a material, comprising:

(a) providing a substrate having a first major surface and a second major surface, substantially parallel to said first major surface;

(b) forming an etch mask on said first major surface, said etch mask comprising at least one nanoparticle;

(c) directionally etching said substrate from said first major surface toward said second major surface, using said etch mask to protect underlying portions of said substrate against said etching, thereby forming at least one pillar underneath said etch mask, wherein said directional etching is carried out using reactive ion etching;

(d) forming a layer of insulating material on said etched substrate, including around said at least one pillar and at least partially covering said at least one pillar; and

(e) removing said at least one pillar to leave at least one said nanopore in said insulating layer.

2. The method of Claim 1 for forming a nanopore array for either aligning or spacing molecules for electronic devices or for forming said mold, wherein: in step (b), said etch mask comprises a plurality of said nanoparticles; in step (c), a plurality of said pillars is formed by said directional etching; in step (d) said layer of insulating material is formed between said pillars and at least partially covering said pillars; and in step (e), said plurality of pillars is removed to leave said array of nanopores.

3. The method of Claim 1 wherein said at least one nanoparticle has an average particle size within a range of about 1 to 10 nm.

4. The method of Claim 1 wherein said at least one nanoparticle comprises an inorganic crystalline core covered with an organic layer.

5. The method of Claim 1 wherein said at least one nanoparticle is formed by depositing a material of a first lattice constant on said substrate wherein said substrate has a second and different lattice constant to create a lattice mismatch and using forces from said lattice mismatch to form at least one nanoparticulate island of said deposited material.

6. (canceled)

7. The method of Claim 1 wherein said insulating material is selected from the group consisting of oxides, nitrides, oxynitrides, diamond-like carbon, and insulating polymers.

8. The method of Claim 7 wherein said insulating material is selected from the group consisting of silicon dioxide, aluminum oxide, silicon nitride, and silicon oxynitride.

9. The method of Claim 7 wherein said insulating material is formed by chemical vapor deposition or by liquid-phase techniques.

10. The method of Claim 1 wherein said etch mask comprising said at least one nanoparticle is removed prior to forming said insulating material.

11. The method of Claim 1 wherein in step (d), said layer of said insulating material is formed to completely cover said at least one pillar and following step (d), said layer of insulating material is reduced in thickness to expose a top of said at least one pillar.

12. The method of Claim 1 wherein said layer of insulating material is reduced in thickness by chemical-mechanical polishing or by an unmasked single-step or multi-step plasma/reactive-ion etch technique.

13. The method of Claim 1 wherein said at least one pillar is removed by selective etching.

14. The method of Claim 1 further comprising filling said at least one nanopore with said material.

15. The method of Claim 14 wherein said material comprises a molecular species.

16. The method of Claim 14 wherein the bottom of said at least one nanopore is electrically conducting.

17. The method of Claim 16 wherein said bottom of said at least one nanopore is made electrically conducting by using as said substrate a material that is electrically conducting.

18. The method of Claim 17 wherein said substrate comprises doped single crystal silicon or a doped polycrystalline silicon layer on said substrate.

19. The method of Claim 14 wherein prior to filling said nanopores, the bottom of said nanopores is covered with a thin tunnel barrier.

20. The method of Claim 14 wherein said material comprises a material selected from the group consisting of semiconductor and magnetic materials.

21. The method of Claim 1 wherein said at least one nanopore has a length of about 5 to 100 nm and a diameter of about 1 to 10 nm.

22. The method of Claim 21 wherein said at least one nanopore has a length of about 10 nm and a diameter of about 1 nm.

23. The method of Claim 1 wherein said substrate is selected from the group consisting of oxides, nitrides, oxynitrides, and carbides.

24. A method for forming at least one molecule in a pre-selected orientation relative to a substrate, said method comprising:

(a) forming at least one nanopore by:

(1) providing said substrate having a first major surface and a second major surface, substantially parallel to said first major surface,

(2) forming an etch mask on said first major surface, said etch mask comprising at least one nanoparticle,

(3) directionally etching said substrate from said first major surface toward said second major surface, using said etch mask to protect underlying portions of said substrate against said etching, thereby forming at least one pillar underneath said etch mask,

(4) forming a layer of insulating material on said etched substrate, including around said at least one pillar and at least partially covering said at least one pillar, and

(5) removing said at least one pillar to leave at least one said nanopore in said insulating layer; and

(b) dispersing said at least one molecule in said at least one nanopore.

25. The method of Claim 24 for forming a molecular array, wherein: in step (2), said etch mask comprises a plurality of said nanoparticles; in step (3), a plurality of said pillars is formed by said directional etching; in step (4) said layer of insulating material is formed between said pillars and at least partially covering said pillars; and in step (5), said plurality of pillars is removed to leave said array of nanopores and further wherein in step (b), a plurality of said molecules is dispersed, one in each said nanopore.

26. The method of Claim 24 wherein said at least one nanoparticle has an average particle size within a range of about 1 to 10 nm.

27. The method of Claim 24 wherein said at least one nanoparticle comprises an inorganic crystalline core covered with an organic layer.

28. The method of Claim 24 wherein said at least one nanoparticle is formed by depositing a material of a first lattice constant on said substrate wherein said substrate has a second and different lattice constant to create a lattice mismatch and using forces from said lattice mismatch to form at least one nanoparticulate island of said deposited material.

29. The method of Claim 24 wherein said directional etching is carried out using reactive ion etching.

30. The method of Claim 24 wherein said insulating material is selected from the group consisting of oxides, nitrides, oxynitrides, diamond-like carbon, and insulating polymers.

31. The method of Claim 30 wherein said insulating material is selected from the group consisting of silicon dioxide, aluminum oxide, silicon nitride, and silicon oxynitride.

32. The method of Claim 30 wherein said insulating material is formed by chemical vapor deposition or by liquid-phase techniques.

33. The method of Claim 24 wherein said etch mask comprising said at least one nanoparticle is removed prior to forming said insulating material.

34. The method of Claim 24 wherein in step (4), said layer of said insulating material is formed to completely cover said at least one pillar and following step (4), said layer of insulating material is reduced in thickness to expose a top of said at least one pillar.

35. The method of Claim 24 wherein said layer of insulating material is reduced in thickness by chemical-mechanical polishing or by an unmasked single-step or multi-step plasma/reactive-ion etch technique.

36. The method of Claim 24 wherein said at least one pillar is removed by selective etching.

37. The method of Claim 24 further comprising filling said at least one nanopore with said material.

38. The method of Claim 37 wherein said material comprises a molecular species.

39. The method of Claim 37 wherein the bottom of said at least one nanopore is electrically conducting.

40. The method of Claim 39 wherein said bottom of said at least one nanopore is made electrically conducting by using as said substrate a material that is electrically conducting.

41. The method of Claim 40 wherein said substrate comprises doped single crystal silicon or a doped polycrystalline silicon layer on said substrate.

42. The method of Claim 37 wherein prior to filling said nanopores, the bottom of said nanopores is covered with a thin tunnel barrier.

43. The method of Claim 37 wherein said material comprises a material selected from the group consisting of semiconductor and magnetic materials.

44. The method of Claim 24 wherein said at least one nanopore has a length of about 5 to 100 nm and a diameter of about 1 to 10 nm.

45. The method of Claim 44 wherein said at least one nanopore has a length of about 10 nm and a diameter of about 1 nm.

46. The method of Claim 24 wherein said substrate is selected from the group consisting of oxides, nitrides, oxynitrides, and carbides.

47. The method of Claim 1 wherein each said nanopore contains one said molecule.

48. The method of Claim 24 wherein each said nanopore contains one said molecule.